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SOLUTION STOICHIOMETRY QUIZ

1. 12.5 g of copper metal is reacted with 5.00 mL of 8.00 mol/L nitric acid, according to the following:

12.5 g 5.00 ml
8.00 mol/L

a) What is the limiting reactant? [5 marks]

$n_{cu} = 12.5\text{ g} \times \frac{1\text{mol}}{63.55\text{ g/mol}} = 0.197\text{mol (available)}$

$n_{HNO3} = \frac{8.00\text{ mol}}{\text{L}} \times 0.005\text{ L} = 0.04\text{ mol (available)}$

$n_{cu}\text{(reacted)} = 0.04\text{ mol } HNO_3 \times \frac{3\text{ mol Cu}}{8\text{ mol } HNO_3} = 0.015\text{ Cu (reacted)}$

$\because n_{cu}\text{(available)} > n_{cu}\text{(reacted)}$ $\therefore$ Copper is the excess reagent

0.197 mol 0.015 mol

$\therefore HNO_3$ is the limiting reagent

b) Calculate the mass of the nitrogen monoxide formed. [3 marks]

$n_{HNO_3} = 0.04\text{ mol}$

$0.04\text{ mol } HNO_3\ (aq) \times \frac{2\text{ mol NO(g)}}{8\text{ mol } HNO_3(aq)} = 0.01\text{ mol NO(g) produced}$

$m = nMM$

$m_{NO} = 0.01\text{ mol NO} \times 30.01\text{ g/mol} = 0.300\text{ g produced}$

c) Calculate the concentration of the aqueous solution that will be produced. [4 marks]

$n_{HNO_3} = 0.04\text{ mol}$

$0.04\text{ mol } HNO_3\ (aq) \times \frac{3\text{ mol } Cu(NO_3)_2(aq)}{8\text{ mol } HNO_3(aq)} = 0.015\text{ mol } Cu(NO_3)_2\text{(aq) produced}$

$C = n / v \quad n = 0.015\text{ mol} \quad v = 0.005\text{L}$

$C_{Cu(NO_3)_2} = \frac{0.015\text{ mol}}{0.005\text{L}} = 3.00\text{ mol/L}$

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2. 500 g of copper metal is reacted with 2.5 L of 3.0 mol/L nitric acid solution. Calculate how much of the copper metal remains after the reaction is complete. [7 marks]

$Cu(s) + 4\ HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2\ NO_2(g) + 2H_2O(l)$

500 g 2.5 L
3.0 mol/L

$$n_{Cu} = 500\ g \times \frac{1\ mol}{63.55\ g} = 7.8678\ mol\ (available)$$

$n_{HNO_3} = CV$

$= 3.0\ mol / L \times 2.5\ L$

$= 7.5\ mol\ (available)$

(limiting reagent, since question says some copper remains unreacted, but we will verify this later on)

$$n_{cu} = 7.5\ mol\ HNO_3 \times \frac{1\ mol\ Cu}{4\ mol\ HNO_3} = 1.875 mol\ (reacted)$$

n_{Cu} (available) $> n_{Cu}$ (reacted)

n_{Cu}(remained) = n_{Cu} (available) - n_{Cu} (reacted)

= 7.868 mol - 1.875 mol

= 5.993 mol

$m = nMM$

m_{Cu}(remaining) = 5.993 mol x 64.55g / mol = 380.84 g

$\therefore$ mass of copper that remains unreacted (expressed to 1 S.D.) is 400 g.